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Managing Risk on the Final Frontier

Risk and Knowledge Management Combine To Support the Work of Rocket Science

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Introduction

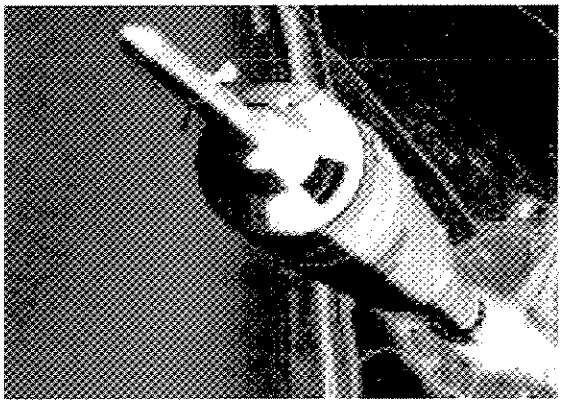

Figure 1. NASA Artist Concept - Ares I-X

The National Aeronautics and Space Administration (NASA), Exploration Systems Mission Directorate (ESMD) has combined the Continuous Risk Management (CRM) discipline with innovative knowledge management (KM) practices to more effectively enable the accomplishment of work. CRM enables proactive problem identification and problem solving in the complex world of rocket science, while KM is used to improve this process.

The exploration risk landscape is indeed challenging with the competing imperatives of: operating safely, staying within the budget, replacing the Space Shuttle, maintaining a balanced Agency workforce, resupplying the International Space Station, exploring beyond LEO, developing advanced technologies, and stimulating the commercial space sector. Complementing CRM is another important business practice - knowledge management (KM). KM at NASA (and in the Federal Government) has come a long way during the past ten years and innovations continue with the advent of greater social networking with Web 2.0.

ESMD's Integrated Risk & Knowledge Management (IRKM) System was initiated in 2006--it helps program managers, scientists, and engineers balance risks and accomplish work in a more effective and efficient manner. The initiative begins with CRM, a technical management process that is part of the systems engineering discipline. CRM requires an iterative evaluation of events that might happen which would prevent you from meeting your objectives—and the proactive implementation of measures to control or mitigate potential negative consequences—or enhance opportunities. An important and novel aspect of the IRKM approach is using CRM as a "cueing function" for KM process implementation. CRM informs KM and KM becomes the enabler of CRM. As shown in Figure 2, the IRKM process flows from the domain of CRM (Home Plate) and notionally moves "around the bases" – each an element in the IRKM System. The second key concept is work process improvement. CRM and KM help reflect on process performance and provide a structure for process optimization. The technology dimension of KM can enhance work team effectiveness by enabling more effective collaboration and communication – again to accomplish work. Hence, the interlocking concepts of risk management - work process optimization and knowledge management are tightly coupled and support each other. The paragraphs below provide a quick look at key elements.

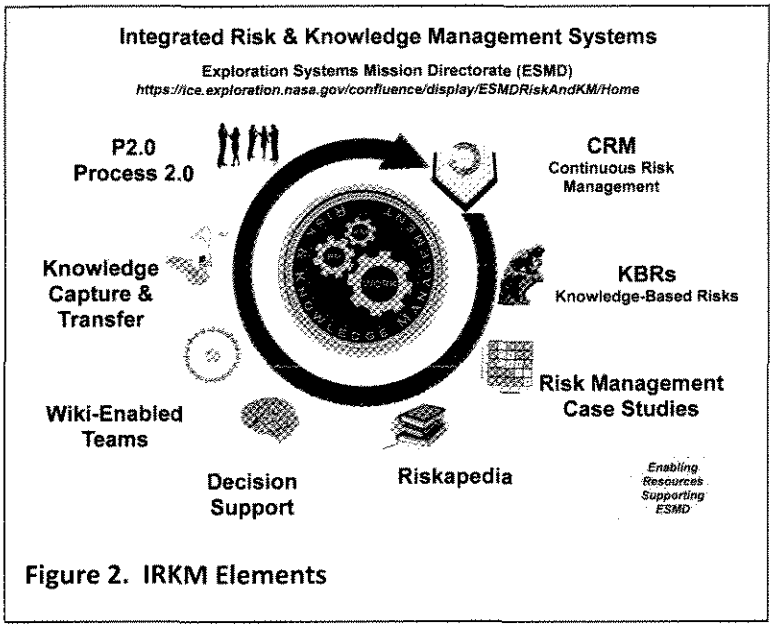

Figure 2. IRKM Elements

Continuous Risk Management (CRM)

The CRM process is a continuous, iterative process that identifies, analyzes, plans, tracks, controls, communicates, and documents risk through all life cycle phases of an organization's product developments. ESMD uses an enterprise risk management approach and a common framework for identifying, analyzing, communicating, and managing risks for ESMD and its performing organizations. Risks are communicated vertically through an escalation process – horizontal integration occurs through a multi-tiered risk management working group and board structure. This network is also used to communicate lessons learned and best practices.

Knowledge Based Risks (KBRs)

ESMD risk records provide the context for KBRs - web-based, multi-media, "knowledge bundles" that provide users with expert advice on risk control and mitigation strategies for specific technical risks. ESMD defines a KBR as a risk record, with associated knowledge artifacts, that provides a story-telling narrative of how this risk was mitigated, what worked or did not work. A KBR is also a means of transferring knowledge in a risk context. As key risks are mitigated, particularly risks *which are likely to recur across other* programs in ESMD, knowledge is captured and transferred. The KBR identifies the effects of mitigation activities, specifically how cost, schedule and technical performance were affected. Instead of a "collect, store and ignore" approach, KBRs form an active collection of lesson *learned which are continually reused* and updated.

Example KBR topics include: Composite Overwrap Pressure Vessels (lightweight storage vessels that require careful handling – and are a potential hazard), Nutation Time Constant (sloshing propellant during coast phase of launch), Tin Whiskers (metallic crystal growth on circuit boards), and EVA Glove (damage to spacesuit gloves during extra-vehicular activity).

Riskapedia

The Riskapedia wiki-space is intended to assist ESMD programs, projects, managers, and workers in implementing life-cycle risk management practices and discipline. Riskapedia is a resource that provides extensive content (tools, techniques, best practices, videos, and lessons learned) addressing the fundamental "blocking and tackling skills" of risk management - risk identification, risk assessment, and risk control and mitigation planning. Riskapedia, is a "Hard Hat Area" that is intended to be << Under Construction >> for life - that's the whole point. This space has been populated with expert-developed content which is intended to evolve over time as users and contributing editors engage in on-going construction of subject matter. Riskapedia is all about user interaction, conversation, evolution, and the ultimately the accomplishment of work. Users have the opportunity to rate content, discuss content, author content (as a contributing editor), ask questions of experts, and use content in the

performance of your work and the management of your risks. The Risk Identification section provides convenient checklists for identifying typical system, programmatic, and integration risks. The Risk Assessment section contains qualitative and quantitative tools and methodologies for analyzing, understanding, and communicating risks. The Control and Mitigation section provides expert knowledge and guidance for mitigating and controlling risk in specific areas.

Risk Management Case Studies

ESMD risk records illuminate top engineering management and technical issues. Risk management case studies provide insight into how similar problems have been addressed in past NASA programs. Each Case is structured to highlight key transferrable aspects of risk management. Transferrable principles include the risk identification, evaluation, and mitigation planning. The proper application of risk management principles can help manage life-cycle costs, development schedules, and technical scope, resulting in safer and more reliable systems for Constellation and other future programs. Our first case study addresses the the Space Shuttle Program's Super Lightweight Tank development. The next case in development examines test and verification management approaches employed on the international Space Station.

Process 2.0 (P2.0)

The IRKM system also has an important work-process-assist element called P2.0, which is in-part modeled on the U.S. Army after-action review (AAR) process. P2.0s are process-focused, collegial, structured reflection events. There has been huge demand for the P2.0 events which assist teams in examining all aspects of a given process including: stakeholders, inputs, outputs, products. P2.0 events use: critical process mapping, structured brainstorming techniques, and Process Failure Modes and Effects Analysis to identify and address work process issues. As an option, P2.0 users can take advantage of the Group Systems, ThinkTank collaboration tool to assist in this process. Most importantly, the method demands and enforces disciplined thinking to drive out actionable process improvements for the team. P2.0s have been used to assist a diverse set of team processes ranging from vibro-acoustic coupled-loads analysis,to the Agency independent assessment processes, to a simple tag-up meeting gone awry. In every case the result has been rapid, transparent, team-authored process improvement.

Knowledge Capture & Transfer (KCT)

KCT activities are designed to document project execution lessons learned and best practices in a contextual manner using a conversation-based format. While overlapping in some respects, KCT differs from P2.0 in that it focuses on project execution rather than recurrent process implementation. KCT is an abrupt departure from the notion of lessons learned databases which often have been hard to use, typically fragment "the story," and most regrettably, lack context. KCT also rejects the notion of asking participants to fill out questionnaires, something no one enjoys doing. Rather, KCT uses the most natural modality – conversation – but carefully structured and controlled conversation. Project risk records are used to guide the initial interviews. A thematic framework is evolved to identify key issue areas and communicate the in an Issue/Opportunity Fishbone diagram similar to that shown in figure 3 below.

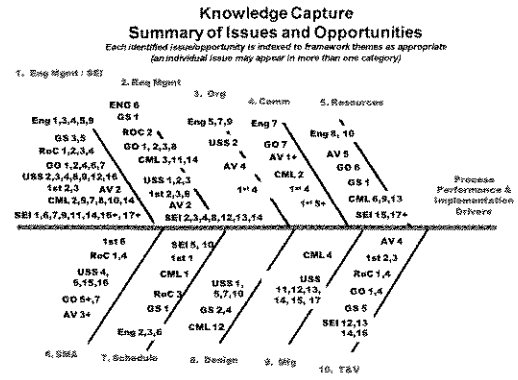

Figure 3. Aggregation of Issues / Opportunities for Improvement

Individual issues are synopsized, aggregated, and a composite analysis is provided. Results are rapidly provided to stakeholders using a variety of communication modalities including: briefings, design review checklists, peer assists, and interactive café's, video interviews and Knowledge-Based Risks. An edited report is also developed as an archive and made available electronically to the project management.

Wiki-Enabled Teams

Wiki-enabled teams perform a set of essential collaboration and knowledge sharing functions across the ESMD directorate. Over 350 wikis provide a multi-functional, web-based, collaboration environment for ESMD teams to accomplish work. An important part of exploiting this technology has been helping teams critically examine their work processes and information architecture, which is then mapped into the tool. Wiki implementation is supported by rapid business process analysis to assist in developing the team charter, stakeholder membership, and refine the knowledge architecture. The wiki provides teams an easy to use, flexible interface to collaborate on documents, conduct discussions, manage calendars, locate information, and, most importantly, work more effectively.

Decision Support

Decision support services include analysis of alternatives, uncertainty modeling, and expert elicitation. In addition, ESMD is developing a cadre of trained facilitators to assist teams in using the Group Systems, ThinkTank decision support technology. This web-based tool provides powerful support for team brainstorming, prioritization, and alternative analysis.

Conclusion – Applicability to Other Organizations

The IRKM-System continues to evolve and innovate to facilitate integration, collaboration, and effective work-process implementation across the complex ESMD enterprise. The fundamental concepts and approach have been broadly scalable within ESMD's diverse work processes (e.g., budget analysis, design and systems engineering, operations planning) and indeed could be applied across (or within) any government, commercial, or academic enterprise.